BBC RD 1976/9

1969
THE QUEEN'S AWARD
TO INDUSTRY

1974
THE QUEEN'S AWARD
TO INDUSTRY

RESEARCH DEPARTMENT **REPORT**

CEEFAX:
initial field trial at u.h.f. of unified standard

M.G. Croll, B.Sc., A.R.C.S.

Research Department, Engineering Division
THE BRITISH BROADCASTING CORPORATION **May 1976**

BBC RD 1976/9
UDC 621.397

CEEFAX: INITIAL FIELD TRIAL AT UHF OF UNIFIED STANDARD

M.G. Croll, B.Sc., A.R.C.S.

Summary

A short series of field trials was conducted in late 1974 to assess the effects of some changes in the specification of the transmitted CEEFAX data waveform brought about by adopting the unified standard parameters.

The results of 24 site tests indicate that these changes reduced the minimum field strength required for a marginal CEEFAX service by about 3·5 dB. The field strength for half the characters on a CEEFAX page to be received correctly the first time a page was requested was found to be some 12·5 dB lower than the minimum required for an acceptable colour television service.

These results can only be taken as initial findings; more extensive field trials would be necessary in order to provide fully reliable conclusions.

Issued under the authority of

Head of Research Department

Research Department, Engineering Division,
BRITISH BROADCASTING CORPORATION
May 1976

(PH-156)

CEEFAX: INITIAL FIELD TRIAL AT UHF OF UNIFIED STANDARD

Section	Title	Page
	Summary	Title Page
1.	Introduction	1
2.	CEEFAX, 'compressed CEEFAX' and CEEFAX/1974 unified standard	1
3.	Receiving and measuring equipment	2
4.	Measurement procedure	3
5.	Extent of the survey	3
6.	Results	3
7.	Conclusions and discussion	3
8.	References	5

(PH-156)

© BBC 2004. All rights reserved. Except as provided below, no part of this document may be reproduced in any material form (including photocopying or storing it in any medium by electronic means) without the prior written permission of BBC Research & Development except in accordance with the provisions of the (UK) Copyright, Designs and Patents Act 1988.

The BBC grants permission to individuals and organisations to make copies of the entire document (including this copyright notice) for their own internal use. No copies of this document may be published, distributed or made available to third parties whether by paper, electronic or other means without the BBC's prior written permission. Where necessary, third parties should be directed to the relevant page on BBC's website at http://www.bbc.co.uk/rd/pubs/ for a copy of this document.

CEEFAX: INITIAL FIELD TRIAL AT UHF OF UNIFIED STANDARD

M.G. Croll, B.Sc., A.R.C.S.

1. Introduction

CEEFAX is an experimental information service transmitted by the BBC in which binary data signals are added to the television waveform during the field-blanking intervals. A unified technical specification for this service and ORACLE, a similar service transmitted by the IBA, was agreed in April 1974. The current specification of this system, now known as broadcast Teletext, has been published jointly by the BBC, IBA and BREMA.[1]

Prior to the proposal of a unified standard, the BBC had experimented with earlier forms of CEEFAX and 'compressed CEEFAX'. Field trials were conducted at UHF[2] which concluded that, with a bit-rate of 6·875 Mbit/s and a data signal level of 50% white level, the picture-signal to r.m.s.-unweighted-noise ratio at which CEEFAX failed was, on average, 26 dB. This compares with a ratio of 35 dB considered to give a just acceptable television picture, giving an effective margin of 9 dB in field strength. From this work it was conservatively predicted that, for a bit-rate of 6·9375 Mbit/s and a data signal level of 71% white level (0·5V), as proposed in the unified specification, the margin between the edge of the CEEFAX service area and the edge of the colour television service area would be increased some 2 dB to 11 dB.

To test this prediction a second short series of field trials has been conducted and the results are reported here. The methods and techniques adopted were similar to those employed during the earlier field trials and some of the sites previously used were re-visited in order to provide a rapid assessment of the effect of the changes in the parameters of the data signal rather than an accurate absolute assessment of the CEEFAX service area with the new unified parameters.

2. CEEFAX, 'compressed CEEFAX' and CEEFAX/1974 unified standard

The essential parameters of the early experimental forms of CEEFAX and 'compressed CEEFAX' are summarised in Table 1. For completeness the corresponding parameters of the unified standard have also been included.

TABLE 1

	Early CEEFAX	'Compressed' CEEFAX	Unified CEEFAX (1974)
Displayed characters per row	32	32	40
Rows per page	24	24	24
Clock-run-in sequence (bits)	16	16	16
Framing pattern	4	4	8
Character parity protection	1 bit odd parity for 7 data bits	1 bit odd parity for 7 data bits	1 bit odd parity for 7 data bits
Header and row address protection	1 bit odd parity for 7 data bits	1 bit odd parity for 7 data bits	Hamming 8 bit groups
Data transmission code	Binary NRZ	Binary NRZ	Binary NRZ
Data bit-rate	4·5 Mbit/s	5·75/6·875 Mbit/s	6·9375 Mbit/s
Data shaping	Raised-cosine	Raised-cosine with spectrum truncated at 4·4 MHz	Raised-cosine with spectrum truncated at 4·4 MHz
Data pulse height relative to peak white	50%	50%	71%

Prior to the investigation, field trials had been conducted using the earlier CEEFAX and 'compressed CEEFAX' transmissions.[2] Here, increasing the bit-rate from 4·5 Mbit/s to 6·875 Mbit/s was found to have no significant effect on the mean field strength at which reception of CEEFAX failed.

With the introduction of the unified standard several important changes were made in the parameters which might be expected to increase the service area of CEEFAX. These are listed below:

(a) Increasing the data pulse height from 50% to 71% of white level.

(b) Adding Hamming protection to the two address and page header words.

(c) Increasing the number of framing bits from 4 to 8.

Of these changes, increasing the data signal level was expected to have the greatest effect upon the service area. The addition of Hamming protection to the row address and page header words was mainly aimed at reducing the extent to which correctly received and stored data are later replaced by corrupt or spurious information.

Other changes shown in Table 1, i.e. increasing the bit-rate from 6·875 to 6·9375 Mbit/s and increasing the number of displayed characters per row, would not be expected to affect the service area for CEEFAX to any significant extent.

3. Receiving and measuring equipment

The equipment used in the previous field trials was re-

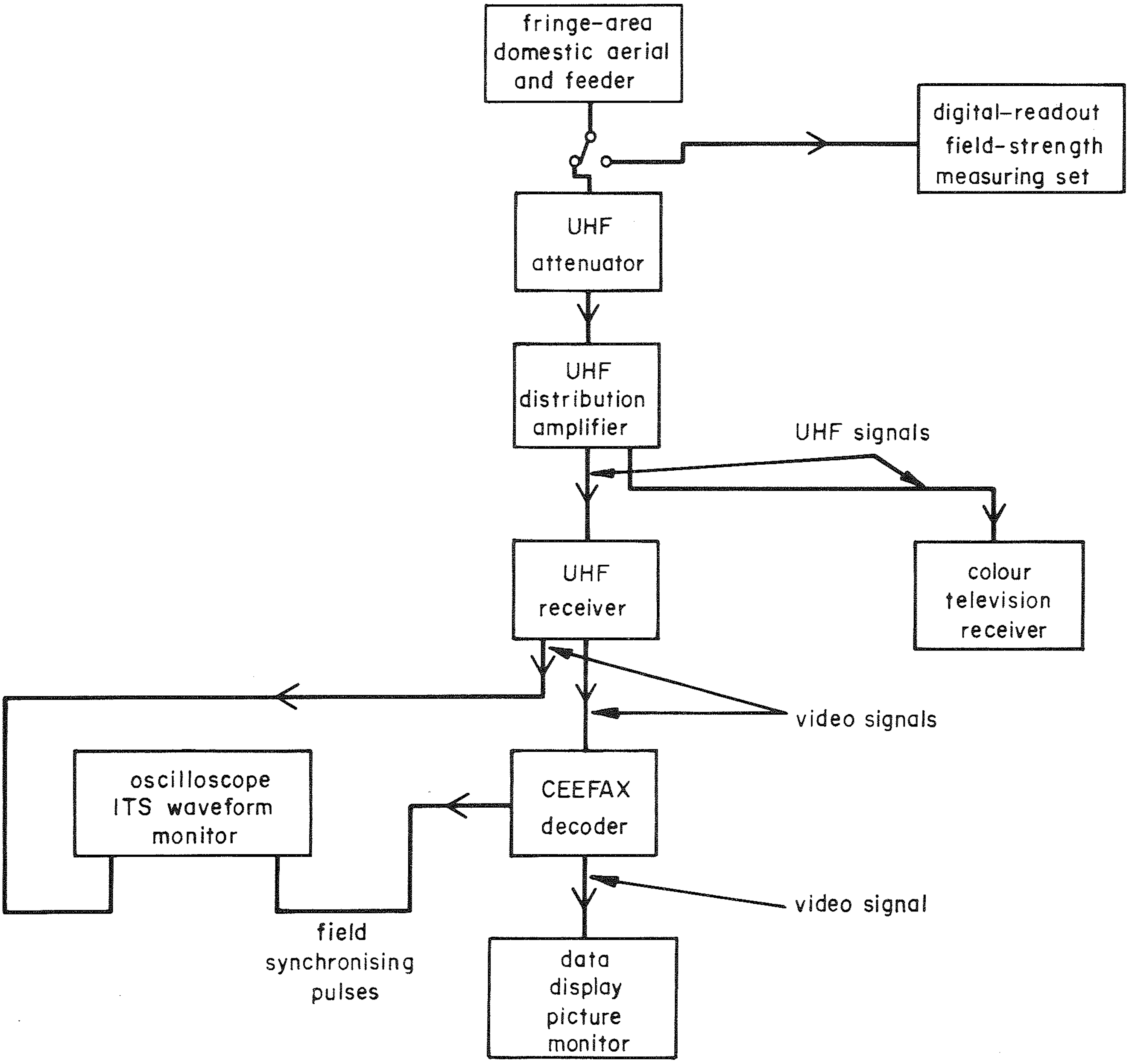
fringe-area domestic aerial and feeder
digital-readout field-strength measuring set
UHF attenuator
UHF distribution amplifier
UHF signals
UHF receiver
colour television receiver
video signals
oscilloscope ITS waveform monitor
CEEFAX decoder
video signal
field synchronising pulses
data display picture monitor

Fig. 1 - Arrangement of equipment in mobile laboratory

assembled as shown in Fig. 1 and installed in a mobile laboratory.

The calibration of each item of equipment was checked. As in the previous experiments, the picture signal-to-noise ratio at the video output of the UHF receiver was measured as a function of the field strength by observing the quasi-peak value of the noise waveform during an unmodulated television line occurring in the field-blanking interval. The results were found to be within 2 dB of those measured previously.

The CEEFAX decoder used in this series of tests was also substantially similar to that used in the earlier tests. Although at the time of the tests, improved data detection circuits were being developed, circuits similar to those used in the earlier tests were used in order to provide a valid comparison.

4. Measurement procedure

In order to enable a rapid assessment of the effects of the changes in the CEEFAX transmission parameters to be made, the measurement procedure used at each site was shorter than had been employed in the previous tests.

At each site the aerial was directed for maximum received signal strength. The value of this signal strength was then recorded and the colour picture displayed on the colour television receiver graded, noting any particular impairments. Then, for three consecutive single acquisitions of a 'clock-cracker'* page the numbers of any blank rows, missing characters (not included in blank rows), wrong characters and wrong rows were recorded.

Lastly the UHF signal from the aerial was progressively attenuated until only about 50% of the 'clock-cracker' page was correctly received on one acquisition; the attenuation required was then noted.

In this site test procedure no attempts were made to measure the picture signal-to-noise ratios, nor the amplitudes and delays of any echoes, using the oscilloscope. It was found that such measurements were time consuming and that the information could be more accurately derived from the measured field strength and from a photograph of the I.T.S. waveform on television lines 19 and 332.

5. Extent of the survey

The survey was carried out using transmissions from the Crystal Palace BBC-1 transmitter (Channel 26). At the time of the tests CEEFAX was being transmitted only on BBC-1, whereas at the time of the earlier field trials CEEFAX was being radiated only on BBC-2. However, as the two transmitters at Crystal Palace are similar and the transmitting aerials co-sited it was not expected that this change would invalidate any comparison between the results obtained in the two sets of tests.

Time did not permit a large selection of sites to be visited so, as far as possible, sites visited in the earlier field trails were revisited.

The sites tested were mainly selected so as to suffer either low field strength or significant amounts of multipath propagation conditions; these sites had been identified during the earlier tests. For many of these sites alternative services from other transmitters were available and at some there were no houses. Hence this survey does not enable any predictions to be made of the percentage of the population who would receive a useable CEEFAX service. The objective was only to make a rapid assessment of the effect of the changes in the system parameters using the same criteria used on the earlier field trials.

6. Results

24 sites were visited in the course of this investigation. Of these, 15 were sites that had been used during the earlier tests. At these 15 sites the field strength was measured to be as much as 7 dB different from that which had been measured at the same site during the earlier tests; further it was found that the degree of multipath was, in some cases, also very different. These differences might be partly explained by the different channels used in the tests. However, the average field strength for these 15 sites was within 0·5 dB of the average for the same sites measured during the earlier tests.

The results for all 24 tests are summarised in Table 2. As had been found before it was difficult to correlate the effect, on CEEFAX reception, of a particular impairment with the visibility of that particular impairment on the colour picture. Moreover, it was found difficult to make accurate, consistent, quality assessments of the picture in the somewhat less than ideal conditions of the mobile laboratory; hence no picture quality grades are presented here.

One site was found where severe multipath caused CEEFAX reception to be only just possible. A photograph of part of the I.T.S. is shown in Fig. 2.

At two sites, both with field strengths of 80 dB (μV/m), ignition interference was just perceptible on the colour receiver. At one of these sites the interference pulses were recorded on the photograph of the I.T.S. which is shown as Fig. 3. For the majority of the time the ignition interference did not cause errors in the received CEEFAX signal; when errors did occur corrupt characters were randomly spread throughout the CEEFAX page.

7. Conclusions and discussion

The results of this short series of UHF field trials using transmissions from the Crystal Palace BBC-1 transmitter

---

* The 'clock-cracker' page contains alternate character codes 11111110;01111111 for the entire page. It provides a severe test of clock synchronisation in the decoder and, because of its repetitive nature, errors or blanks are easily spotted.

TABLE 2

	Number of sites tested	Average field-strength at which CEEFAX reception failed* dB (μV/m	Equivalent picture to r.m.s. unweighted noise ratio dB
Sites with only receiver noise interference	10	52·5	22·5
Sites with multipath interference	12	56·5	26·5
Sites with impulsive interference	2	54·0	24·0
Sites with co-channel interference	None	–	–
City sites. Combined interference	None	–	–

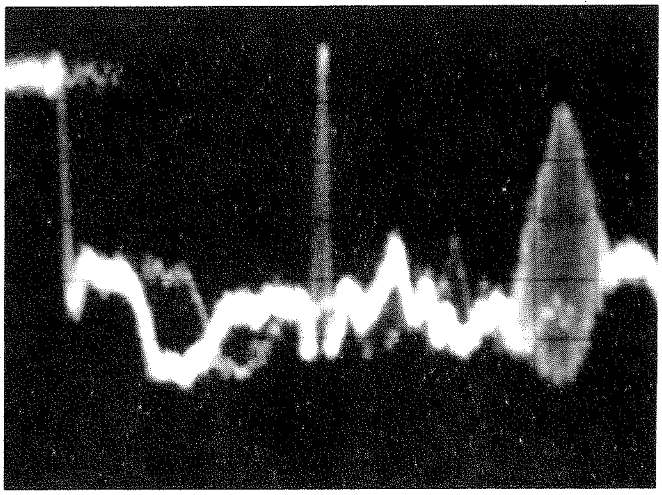

Fig. 2 - Example of severe multipath where CEEFAX reception just possible

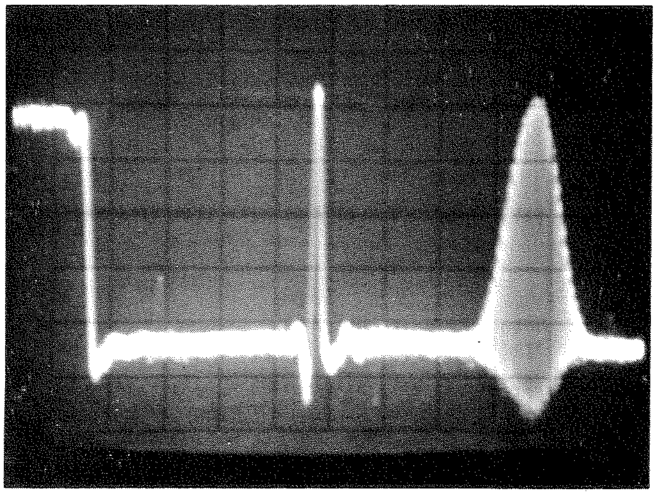

Fig. 3 - Example of ignition interference — CEEFAX performance not significantly effected

were that the average picture-to-r.m.s. unweighted noise ratio at which CEEFAX reception failed* was 22·5 dB for the unified-standard CEEFAX. This figure shows a 3·5 dB improvement over the equivalent figure for 'compressed CEEFAX' having a similar bit-rate and implies a 12·5 dB field strength margin over the value normally assumed to define the edge of the colour television service area.

These results confirm that the predictions of service area for the unified standard CEEFAX based on the results of the field trials conducted using the earlier CEEFAX and 'compressed CEEFAX' were somewhat conservative.

The effects of multipath interference were found to be largely as expected from the earlier tests. Increasing the degree of digital protection of the transmitted CEEFAX signal was found to reduce the tendency for entire lines or pages of incormation to be lost at the decoder when impulsive interference was present. It may also have contributed to the fact that the improvement in the service area was a little greater than had been expected from the changes in the CEEFAX parameters.

Although the survey reported here was not so extensive as the earlier field-trials the results achieved appear to be consistent with those obtained earlier.

The definition of a marginal CEEFAX service used in the work reported to date may not be accurately representative. In practice, the definition of the edge of the CEEFAX service area must be more stringent than that whereby 50% of the characters are correctly received each time a page is acquired; even a few character errors on a particular page might involve considerably dissatisfaction for the user. However the nature of a digital signal is such that beyond a critical point, increased signal impairment causes a rapid degradation in the output. As a result any small change in the definition of marginally satisfactory CEEFAX signal is unlikely to make significant changes to the service area or the percentage of the population served by these transmissions.

---

* i.e. 50% of the characters were received correctly every time a page was first acquired.

8. References

1. Specification of standards for broadcast Teletext signals, published jointly by the BBC/IBA/BREMA at the IEE/IERE/RTS Colloquium on Teletext, January 13, 1976.
2. STEBBINGS, D.W. CEEFAX: UHF field trials. BBC Research Department Report No. 1975/12.

SMW/DS